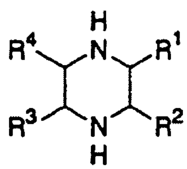
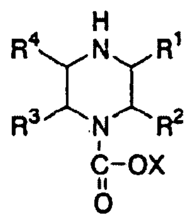
CLAIMS

1. A process for producing an oxycarbonyl-substituted piperazine derivative, in which a piperazine derivative represented by general formula (1) is oxycarbonylated to produce an oxycarbonyl-substituted piperazine derivative represented by general formula (2)


(1)


(2)

(where R^1, R^2, R^3 and R^4 denote, respectively independently, i) a hydrogen atom, ii) an alkyl group with 1 to 4 carbon atoms, iii) an alkoxy group with 1 to 4 carbon atoms, iv) a halogen group, v) a carboxyl group, vi) a carbamoyl group, or vii) an N-alkylcarbamoyl group with 1 to 4 carbon atoms in its alkyl group; X denotes i) an alkyl group with 1 to 4 carbon atoms, ii) an alkenyl group with 2 to 4 carbon atoms, iii) an alkynyl group with 2 to 4 carbon atoms, iv) an aralkyl group not substituted in the aromatic ring, or substituted by an alkyl group with 1 to 4 carbon atoms or by an alkoxy group with 1 to 4 carbon atoms or by a halogen group, or v) an aryl group not substituted in the aromatic ring, or substituted by an alkyl group with 1 to 4 carbon atoms or by an alkoxy group with 1 to 4 carbon atoms or by a halogen group; excluding the case where all of R^1, R^2, R^3 and R^4 denote a hydrogen atom respectively), characterized in that an organic solvent with a water content of 15 wt% or less is used.

2. A process for producing an oxycarbonyl-substituted piperazine derivative, according to claim 1, wherein a reagent represented by general formula (3) or general formula (4)

$$\mathrm{Y{-}\overset{\overset{O}{\|}}{C}{-}OX} \qquad (3) \qquad\qquad \mathrm{XO{-}\overset{\overset{O}{\|}}{C}{-}O{-}\overset{\overset{O}{\|}}{C}{-}OX} \qquad (4)$$

(where X denotes i) an alkyl group with 1 to 4 carbon atoms, ii) an alkenyl group with 2 to 4 carbon atoms, iii) an alkynyl group with 2 to 4 carbon atoms, iv) an aralkyl group not substituted in the aromatic ring, or substituted by an alkyl group with 1 to 4 carbon atoms or by an alkoxy group with 1 to 4 carbon atoms or by a halogen group, or v) an aryl group not substituted in the aromatic ring, or substituted by an alkyl group with 1 to 4 carbon atoms or by an alkoxy group with 1 to 4 carbon atoms or by a halogen group) is used.

3. A process for producing an oxycarbonyl-substituted piperazine derivative, according to claim 1 or 2, wherein the X in the general formula (2) denotes a tert-butyl group or benzyl group.

4. A process for producing an oxycarbonyl-substituted piperazine derivative, according to claim 2, wherein the reagent represented by the general formula (3) or the general formula (4) is benzyl chlorocarbonate or di-tert-butyl dicarbonate.

5. A process for producing an oxycarbonyl-substituted piperazine derivative, according to claim 1, wherein the organic solvent is an alcohol.

6. A process for producing an oxycarbonyl-substituted piperazine derivative, according to claim 1, wherein the R^1 in the general formula (1) and the general formula (2) denotes a methyl group, and R^2, R^3 and R^4 denote a hydrogen atom respectively.

7. A process for producing an oxycarbonyl-substituted piperazine derivative, according to claim 1, wherein the compounds represented by the general formula (1) and the general formula (2) are optically active substances.

8. A process for producing an oxycarbonyl-substituted piperazine derivative, according to claim 1, wherein when the piperazine derivative represented by the general formula (1) is oxycarbonylated, a nitrogen-containing aromatic compound is made to coexist.

9. A process for producing an oxycarbonyl-substituted piperazine derivative, according to claim 8, wherein the pKa of the nitrogen-containing aromatic compound is 7 or less.

10. A process for producing an oxycarbonyl-substituted piperazine derivative, according to claim 9, wherein the nitrogen-containing aromatic compound is pyridine or a pyridine derivative.

11. A process for producing an optically active oxycarbonyl-substituted piperazine derivative, according to claim 7, wherein the diastereomer salts of an optically active piperazine derivative and an optically active resolving agent, obtained by optical resolution using the optically active resolving agent, or the optically active piperazine derivative obtained by decomposing the salts is used as the raw material.

12. A process for producing an optically active oxycarbonyl-substituted piperazine derivative, according to claim 11, wherein a piperazine derivative obtained by optically resolving a piperazine derivative provided as a racemic modification in the presence of a lower carboxylic acid or mineral acid using 0.5 to 4.0 times by weight, based on the amount of the piperazine derivative, of a solvent, is used as the raw material.

13. A process for producing an optically active oxycarbonyl-substituted piperazine derivative, according to claim 11 or 12, wherein the optically active resolving agent is optically active tartaric acid.

14. A process for producing an optically active oxycarbonyl-substituted piperazine derivative, according to claim 12, wherein the lower carboxylic acid or mineral acid is at least one selected from acetic acid, propionic acid, hydrochloric acid and sulfuric acid.

15. A process for producing an optically active oxycarbonyl-substituted piperazine derivative, according to claim 12, wherein the solvent used for performing optical resolution is water or a hydrous alcohol.

16. A process for producing an optically active oxycarbonyl-substituted piperazine derivative, according to claim 11, wherein when the water soluble diastereomer salts obtained by optical resolution from an optically active piperazine derivative and optically active tartaric acid are decomposed, a salt of an alkaline earth metal is used in a solvent containing 50 wt% or more of water.

17. A process for producing an optically active oxycarbonyl-substituted piperazine derivative, according to claim 16, wherein the salt of an alkaline earth metal is any one of hydroxides, halides, sulfates and carbonates.

18. A process for producing an optically active oxycarbonyl-substituted piperazine derivative, according to claim 17, wherein the hydroxide of an alkaline earth metal is any one of magnesium hydroxide, calcium hydroxide, strontium hydroxide and barium hydroxide.

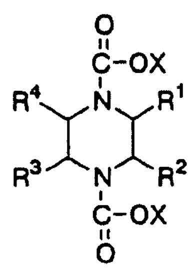
19. A process for producing a highly pure oxycarbonyl-substituted piperazine derivative, characterized in that the oxycarbonyl-substituted piperazine derivative obtained in claim 1 is refined by

(1) a step of washing using an organic solvent of 10 wt% or less in the mutual solubility with water at 20°C in water solvent of pH 3 or less, and/or

(2) a distillation step.

20. A process for producing a highly pure oxycarbonyl-substituted piperazine derivative, according to claim 19, wherein the organic solvent of 10 wt% or less in the mutual solubility with water at 20°C is an aromatic hydrocarbon.

21. A highly pure oxycarbonyl-substituted piperazine derivative composition, characterized in that the total of the contents of the impurities represented by the following general formulae (5) to (8):



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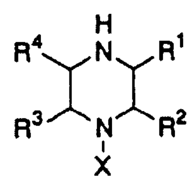

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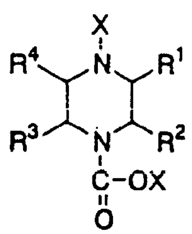
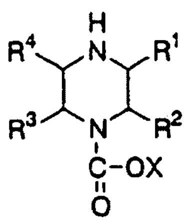


(7)

XOH (8)

(where R^1, R^2, R^3 and R^4 denote, respectively independently, i) a hydrogen atom, ii) an alkyl group with 1 to 4 carbon atoms, iii) an alkoxy group with 1 to 4 carbon atoms, iv) a halogen group, v) a carboxyl group, vi) a carbamoyl group, or vii) an N-alkylcarbamoyl group with 1 to 4 carbon atoms in its alkyl group; X denotes i) an alkyl group with 1 to 4 carbon atoms, ii) an alkenyl group with 2 to 4 carbon atoms, iii) an alkynyl group with 2 to 4 carbon atoms, iv) an aralkyl group not substituted in the aromatic ring, or substituted by an alkyl group with 1 to 4 carbon atoms or by an alkoxy group with 1 to 4 carbon atoms, or v) an aryl group not substituted

in the aromatic ring, or substituted by an alkyl group with 1 to 4 carbon atoms or by an alkoxy group with 1 to 4 carbon atoms; excluding the case where all of R^1, R^2, R^3 and R^4 denote a hydrogen atom respectively) contained in a composition containing the oxycarbonyl-substituted piperazine derivative represented by general formula (2):



(2)

(where R^1, R^2, R^3 and R^4 denote, respectively independently, i) a hydrogen atom, ii) an alkyl group with 1 to 4 carbon atoms, iii) an alkoxy group with 1 to 4 carbon atoms, iv) a halogen group, v) a carboxyl group, vi) a carbamoyl group, or vii) an N-alkylcarbamoyl group with 1 to 4 carbon atoms in its alkyl group; X denotes i) an alkyl group with 1 to 4 carbon atoms, ii) an alkenyl group with 2 to 4 carbon atoms, iii) an alkynyl group with 2 to 4 carbon atoms, iv) an aralkyl group not substituted in the aromatic ring, or substituted by an alkyl group with 1 to 4 carbon atoms or by an alkoxy group with 1 to 4 carbon atoms, or v) an aryl group not substituted in the aromatic ring, or substituted by an alkyl group with 1 to 4 carbon atoms or by an alkoxy group with 1 to 4 carbon atoms; excluding the case where all of R^1, R^2, R^3 and R^4 denote a hydrogen atom respectively), is 2 liquid chromatography area % or less based on the total of the content of the oxycarbonyl-substituted piperazine derivative represented by the general formula (2) and the contents of the impurities.

22. A highly pure oxycarbonyl-substituted piperazine derivative composition, according to claim 21, wherein every R^1 in the general formulae (2) and (5) to (8) denotes a methyl group and every R^2 to R^4 denote a hydrogen atom respectively.

23. A highly pure oxycarbonyl-substituted piperazine derivative composition, according to claim 21, wherein X in the general formulae (2) and (5) to (8) denotes any one of a tert-butyl group, phenyl group and benzyl group.

24. A highly pure oxycarbonyl-substituted piperazine derivative composition, according to claim 21, wherein the piperazine derivative represented by the general formula (2) is an optically active substance in which the carbon atom having R^1 attached is an asymmetric carbon atom.